SCIENCE:

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ON MATTER AS A FORM OF ENERGY.

In the vortex-ring theory of matter as propounded by Sir William Thomson, the characteristic differences between the elements is supposed to be due to complications in the rings themselves, as they may be knotted in innumerable ways. Several such forms are drawn in the memoir, and one such is stamped upon the cover of "The Unseen Universe," by Tait and Stewart.

This vortex-ring theory assumes that matter is a *form of energy*, not interchangable with the other variable forms, such as heat, electricity, etc., for the simple reason that its *form* renders it impossible, but if the elements be forms of energy, the law of energy may possibly be traced in them. Now, the energy of a given mass of matter varies as the square of its velocity, but the *properties* of the mass vary with the form of the energy, that is to say, the physical properties of a heated body are not identical with those of the same body when it is cool, but possesses the same amount of energy in free path motion. The physical properties of atoms and molecules vary with atomic and molecular velocities; for example, whether a piece of iron or steel is magnetic or not depends upon its temperature, that is, its rate of molecular vibration. It is not, therefore, *a priori* improbable that such differences as exist between the ultimate atoms constituting what we call *mass*, may be due to relative velocities of rotation of the vortex-ring. Atomic weights represent numerically these constant differences, and one might expect to find in any one of these atomic weights the two factors that constitute energy, namely a mass (or its equivalent) and a velocity; so we might write $\frac{m\,v^2}{2}$ = atomic weight. Applying this to a specific case, suppose $\frac{m\,v^2}{2} = 75$ = atomic weight of Arsenic; by inspection it is seen that $m = 6$ and $v = 5$. If $m = 6$ and $v = 2$, then $\frac{6 \times 2^2}{2} = 12$ = At. Wt. Carbon. Let a table now be constructed $m = 6$ and v with values 2, 3, 4, and so on, and there results a series of numbers N either exactly the same as the atomic weights of some of the elements or a very close approximation to such numbers. The elements have their symbols under E with their atomic weights as given under At. Wt. for comparison.

$\frac{mv^2}{2}$ = ENERGY=ATOMIC WEIGHT.

	N.	E.	At.Wt.		N.	E.	At. Wt.
$m=6$				$m=9$	18	?	----
$\frac{6\times 2^2}{2}=$	12	C.	12		40.5	Ca.?	40
					72	?	m
$\frac{6\times 3^2}{2}=$	27	Al.	27		112.5	Cd.	111.6
					162	?	----
	48	Ti.	48		220	?	----
	75	As.	75	$m=11$	22	?	----
	108	Ag.	108		49.5	?	----
	147	Di.	147		88	Sr.	87.2
	192	?	---		137.5	Ce.	137
$m=7$	14	N.	14			Ba.	136.8
	31.5	P.?	31		183	W.	184
	56	Fe.	56	$m=12$	24	Mg.	24
	87.5	Sr.	87.2		54	Mn.	54
	126	I.	127		96	Mo.	95.8
	171.5	Er.?	170.6		125	?	----
	224	?	---	$m=13$	26	?	----
$m=8$	16	O.	16		58.5	Ni.	58.6
	36	Cl.?	35.5			Co.	58.6
	64	Cu.	63.3		104	Ru.	103.5
	100	?	m			Rh.	104.2
	144	?	m		162.5	?	----
	196	Au.	196		234	Th.	233.9
		Pt.	196.7				
		In.	196.7				
		Os.	198.6				

By changing the value of m to 7, 8, 9, etc., a new series of numbers is obtained and the process is carried until the resulting number is higher than any known atomic weight, namely, that of Thallium 233.9. Where the number obtained is not that of any known atomic weight an interrogation point is placed. In several cases the resulting number is the same as the ones given by Mendelejeff as those of probable elements yet to be discovered; for example, in table $m = 9$. 72 is such a number and is marked m in the line of atomic weights.

Now, here is a series of forty numbers calculated serially, and thirty-three of them are either the exact atomic weights of elements or vary less than one unit from them, and it does not seem probable that so large a proportion could be the result of chance, for the numbers range from 12 to 234. Moreover, by carrying the process still further many more of the atomic weights are obtained. Thus, with $m = 13$ we have Co. Ni. Ru. Rh. and Th.

$m = 14$, Si. Cu. Cd. and one of Mendelejeff's hypothetical ones.

$m = 15$ only Antimony, 120.

$m = 16$ S. Te. Hg.

$m = 17$ Se. Ce.

$m = 20$ Ca. Zr.

It must be remembered that with this large value for m, only three or four calculations are possible without obtaining numbers quite beyond any known atomic weights; for instance, when $m = 20$, only three calculations can be made, two of which are atomic weights.

With 66 serial computations, 49 elements are determined; 74 per cent. and more than that if Mendelejeff's hypothetical elements may be counted.

If there be any underlying truth in this theory of calculation, then the conception of the elements will be much simplified, for it will dispense at once with complexity in the atom, and substitute a common form for all, differing arithmetically from each other in size and velocity. The only conception I have of the term m corresponding to *mass*, is a relative *volume* of ether in rotation with certain velocity.

TUFTS COLLEGE, MASS. A. E. DOLBEAR.

RECENT ADDITIONS TO THE E. M. MUSEUM AT PRINCETON COLLEGE.

HENRY F. OSBORN, S. D.

The E. M. Museum of Geology at Princeton has recently purchased Messrs. Ward & Howell's well-known collection of fossil animals and plants. Under the partial supervision of these gentlemen the collection has been unpacked and hastily arranged in the cases, and as it has never been fully displayed before, it now appears to very great advantage and possesses peculiar interest. The east wing of the museum already contains the collections made by the Princeton western parties during the summers of 1877 and '78. These include several hundred specimens of fossil insects preserved in the delicate Miocene shales of Florissant, Colorado, and leaves from the same neighborhood. The former have already passed into the hands of Dr. Scudder for identification. Still more valuable is a large collection of fossil leaves from Strata closely overlying the Lower Eocene Lignitic Beds, near Black Butte, Wy. Terr. These have been studied by Dr. Lesquereux; he pronounces them of great novelty as contributing largely to our knowledge of the extent of the Eocene Flora, and they will form the subject of a special memoir to be published by the museum.

Among the western Vertebrate collections are nearly complete skeletons of various members of the Dinocerata family, parts of which have been figured and described in bulletins from the museum. These, together with numerous specimens of *Palæosyops* and allied genera, from the now classical beds of the Henry's Fork and Bitter Creek country, Wy. Terr., together with a great variety of carnivorous, rodent, lemurine and perhaps insectivorous forms, many of which are undescribed, give an admirable idea of the fauna inhabiting the Lower Eocene. In addition to these are many complete turtles and remains of lizards, snakes and birds. Representing the Miocene is a collection from Colorado including widely different forms. Prof. Cope, who has kindly glanced over the whole collection, pencil in hand, pronounces several of these forms new to science.

The Ward collection is, however, of much greater value to the general student, as it includes representative specimens from almost every age and country—from the disputed *Eozoon canadense* of the Laurentian to the Post Pliocene cave bear and Irish elk. It is the result of seventeen years of intelligent travel, purchase and selections, Mr. Ward's theory being to perfect the collection by constantly substituting the best obtainable examples of each type, not aiming at a complete series for each age, but giving a synoptic view from the dawn of life upwards. In this he has succeeded, we have little doubt, far beyond his own expectations at the outset, and although his catalogues have made this collection familiar to many palæontologists in this country, it well deserves a brief description here.

The Silurian corals, crinoids and trilobites fill the first cases. The latter are very fine. Among them is the outline of an *Asaphus gigas* indicating an animal over 12 inches long. On large stone slabs are other Crustacea, *Eurypterus* and *Pterygotus*. These are the earliest of a series represented in the Jurassic by a fine collection from the Solenhofen Beds and throughout by numerous Trilobites. The Solenhofen crustacea include, among others, *Peneus, Glyphea, Eryon, Limulus, Æger*, and a very perfect *Megachirus*, while from the English chalk are some fine fossil crabs, *Enoploclytea, Hoploparia*, etc.

The remains of Devonian Ganoids are very numerous; *Osteolepis, Cheirolepis, Pterichthys, Cephalaspis* and other genera characteristic of the middle and lower Devonian. Most interesting, however, is a fine block containing a number of *Holoptychii* from the old red sandstone, which specimen comes direct from Hugh Millers's collection. From the Lias beds of Lyme Regis are well preserved specimens of *Dapedius, Lepidotus, Eugnathus* and others varying in length from one to three feet. There are fish remains from each epoch. The Solenhofen beds have furnished a very beautiful group, including *Cakuras, Lepidotus, Leptolepis, Aspidorhynchus* and others, imbedded in a clear yellow shale.

There are fine examples of *Lepidodendron* and *Sigillaria* from the English, Prussian and American coal measures; also, many ferns. Among these are perfect remains of *Sphenopteris* and *Pecopteris* from the Scottish coal measures, with a full series from Mazon Creek, Illinois. The fossil flora throughout is numerous, with good collections from the German, Italian and French Tertiary deposits.

From the Jurassic are eleven entire Saurians marked for their exceptional beauty, rather than great size. An *Icthyosaur*, over 11 feet in length, is the largest of a number of skeletons of this genus, and is finely preserved. One complete skeleton and several parts give a very correct idea of *Plesiosaurus*. A head of *Mistriosaurus* complete, rare in this country. From the Wurtemburg Lias is a large *Teleosaur* with the ventral scales in position. There is also a humerus of *Pliosaurus*. Besides these are many fragments; the ossified Sclerotic of Icthyosaurus and parts of the neck, pelvic and shoulder girdles affording a complete study. Probably belonging to the saurians, too, are the so-called bird tracks from the Triassic sandstone of the Connecticut River Valley, including tracks assigned to *Brontozoum, Anisopus* and other genera. Also of the five-toed *Cheirotherium*, supposed to mark the steps of *Labyrinthodon*.

The Echinoderms can be studied almost without interruption. In the earlier crinoid series are *Periechocrinus* and *Pentacrinus* from the older strata. The latter are represented beautifully and in profusion from the Lyme Regis locality, England. Among later forms are *Apiocrinus* and Eucrinus Lilliiformis, a rare specimen from the Brunswick Muschelkalk. In the Echinoid series are perfect specimens of *Periaster, Holaster* and *Hemiaster*, in addition to many others. Beautiful specimens of *Asterias* and *Astropecten* and *Ophiorderma* from the English Lias represent in part the Star Fishes.

The Cephalopods are a great feature of the collection,

beginning with *Endoceras, Gyroceras, Phragmoceras* and others characteristic of the Silurian merging into the more elaborate and coiled *Goniatites, Nautilus* and *Orthoceratites* of the Carboniferous, and into these forms and the *Ammonites* in the Cretaceous. The latter appear in great elegance and profusion from the Lias. In this and the two succeeding ages in which this family reached its maximum the Ammonite and Nautilus group are represented by a number of genera. The series closes in the multiplicity of Cretaceous forms *Ancyloceras, Crioceras, Scaphites, Hamites, Toxoceras* and many others. A heavy slab covered with Trigonia is noticeable among the Lamellibranchs. But a mere enumeration of these series and other Invertebrates that have not been mentioned gives but an inadequate impression of their value as a typical collection, which rests so largely, not upon their number but upon their exceptional perfection and completeness.

From New Zealand are the recent struthious birds, the collection containing many incomplete skeletons of *Meinornis, Dinornis* and *Palapteryx*, and completing the series are three fine Moas, one of them standing 8 feet high. There are important remains of *Halitherium, Titanotherium* and *Rhinoceros*, the latter from the Black Hills. From the Pleistocene shell marl underlying the peat beds near Limerick is a tall Irish elk, *Megaceros Hibernicus*, quite rare in this country. A cave bear from the south of France is one of the most perfect specimens that has been found. It is mounted complete, the ribs and a few vertebræ alone having been restored. These, with a large mastodon from Hudson, N. Y., a skull of Bos Primigenius, and many scattered Mammalian remains give an admirable idea of the Post Pliocene fauna of Europe and America.

The east wing of the museum is almost entirely filled by the collection. It contains no plaster, but the originals of over 130 of Ward's series of casts. It reflects the greatest credit upon the intelligence and energy of its collector. It will come into immediate service in connection with a lately instituted course of lectures upon Palæontology, and give new impetus to the general interest in Biology at Princeton.

THE CLASSIFICATION OF SCIENCE.

REV. SAMUEL FLEMING, LL. D., PH. D.

II.

PRINCIPLES OF CLASSIFICATION.

Science may be properly classified with respect to either the order and facts of nature, or the laws of thought and methods of obtaining the knowledge of facts. In respect to the first basis, the classification may proceed upon the twofold method of arranging the order and laws of phenomena, separately considered, or of considering these in their immediate connection. And while either special method involves the complex process of nature, which is the province of philosophy in the discovery of laws,—the object of classification is to set forth the order of facts and laws which have already been discovered. It is a statement of their connections as brought within the scope of observation, as they stand in their completeness of order, while many facts may still remain unknown. Processes are continually going on in the physical realm, as exhibited in the heavens and in the earth. It is hence not a statement of historical development of each particular science, nor of the body of sciences. It is not an arrangement according to the chronological order of discovery of the facts. It is not a curriculum or course of study for discipline and acquisition. Such a course is arranged with reference to a harmonious development of mind, and requires the prosecution of diverse studies pursued simultaneously. Yet a proper classification proceeds upon the method of arranging or grouping the subordinate sciences according to both the order of philosophic inquiry, and of the subordination of facts and principles to the divisions and uses of science from the lower to the higher, and from phenomena to laws and applications.

Further, any scheme of clasification, founded upon material existences and relations irrespective of the immaterial entities which give qualities and motion to the material, must be radically defective. The fact of an order of succession in respect to the modification of the primary Force which inheres in matter, is too obvious to need more than a statement of the fact. Thus, in organic existence, the all-related force of Gravity is *general*, being applied to all bodies, whatever their constituents or mode of combination, while modified forms of this principle are limited to specializations. As at every step in the gradation of material existences, the order of nature is from the inorganic to the organic, so these terms involve the general and the special, and the addition proceeds from the lower and more general forms of force to the higher, more limited and special. Thus, also, in organic being we find Life as a common or general substance or entity, forming the basis of the general division of science denominated Biology. The lowest specialized form of life pertains to Botany,—the science of organic unconscious vegetal life, including many classes; the next higher pertains to Zoology, which is the science of that form of organic life, which has consciousness and animation, including many classes, and subordinate orders, kinds and species. The highest in gradation of being pertains to Anthropology, the science of the form of organic life which is conscious and rational, limited to mankind. In every higher order a new capacity has been added. It has been a "life unto life."

This natural order of classification from generals to specials, and from the lower to the higher, may be illustrated by the following diagrams, commencing with the lower, or gravitation, as in reading the scheme of classification accompanying this paper:

Life, { Man = organization + sensation + rational mind.
Animal = organization + consciousness and sensation.
Plant = organization.

Force, { Special: Chemical affinity.
Special: Cohesion.
General: Gravitation.

The fundamental distinctions of this classification are those which pertain to the body of sciences included in the scheme given. They are first, *Ontology*, the science of being, or the material or immaterial substances, qualities and attributes of universal being. This properly includes not only the general divisions given, but those which relate to the superior orders of being not given, viz.: Angeology, Christology and Theology. A classification of all Science, therefore, embraces these subjects. Ontology includes three general divisions: Cosmology, Biology and Anthropology. These are arranged in their natural order, as based upon the succession of immaterial or spiritual entities united with their respective material forms. Such order is essentially *serial*: in other words, there is a gradation of existences, as just noticed, and as indicated by the branch and group-descriptive terms given in the body of the scheme, as *Physico-dynamic*, etc.

Each general division includes its subordinate divisions or departments. Cosmology, the science of inorganic nature, includes three departments: Physical, Mechanical and Chemical Philosophy. The general term, Dynamology, formed upon the Greek etymon *dunam*, is used to designate the science of the immaterial principle, Force, as Biology designates the science of the vital principle, or Life. Biology and Anthropology include the several branches or departments as given. Individuals of a group are allied by some mode, principle or law distinguishing them from others in special respects.

The progress of science within the past few decades, and the very wide applications rendering divisions of scientific research and use indispensable, has made it necessary more and more to distinguish the several subordinate branches of a general division with reference to special relations and purposes of science. What has been denominated physical science in the reeent past is found to include too extensive a field of culture and use, and to require too vast an amount of scientific labor in research, analysis and application, both for individual gratification and for the demands of science. Then "Natural Philosophy" monopolized the whole field. Now Chemical Philosophy has taken the rank of a distinct department, and has extended its domain in every direction wherever it could find a field of research. It has even been obliged to review its own analyses, and to criticise its own results, by further experiment upon its own elements, to determine whether they are themselves compounds. And the analyses have yielded important fruits. Recently four new elements—cæsium, rubidium, thallium and iridium--have been detected by the new and wonderful method of the Spectrum Analysis, a notice of which will be given farther onward.

But Mechanical philosophy has an equal claim to distinction as a special department. Its aims and uses are practical—the relations and applications of matter and motion to mechanical effects; and in this age of inventive genius and of vastly extended applications of mechanical force to the demands of utility, give increasing importance to this department of science. The distinguishing triumphs of the past few years have resulted from the conservation of those forces and agencies which appear phenomenally in their general relations in physical nature, but are now specialized in this department for the higher uses of human society. Thus the form of force which has operated naturally as heat in all the previous history of matter, has become a science in mechanical philosophy, manipulated and controlled by scientific art, and takes the name of Thermotics, a science of vast extent and application. Hydrology has become specialized in Hydro-dynamics, Aerology in Pneumatics, Electricity in Electro-magnetism, etc. The subdivision of Physico-dynamic science into three departments—Physics, Mechanics and Chemics—seems to be demanded by the vastly extended range and special applications of these, as well as by the legitimate distinction recognized between *phenomena* and *laws*.

Cosmogony is treated as a branch of Astronomy. It is obvious this is its place, from the fact that Stellar Astronomy grows out of it, and includes its forming masses and nebular states. This contemplates a prior state, and the processes of the formation of special masses from the original mass of nebulous matter. The advancement from nebulous masses to globes in the various stages of condensation gives Stellar Astronomy. The sun is one of the stars, and is specialized as the center of the system to which our planet belongs, and hence Solar Astronomy is a consequent, and its place above Stellar Astronomy is appropriate. Again; our earth, far back in the periods of world-formations, was in its cosmogenic stage, forming part of the great nebulous cosmos; hence the term *geogony*, the science of the genesis of the earth, is grouped with *cosmogony*. But while the greater part of the earth's interior is still in its gaseous state, the facts pertaining to its crust create a new sub-group, as Geology, Mineralogy and Seismology.

Biology is divided into two general departments, while it includes three sub-sciences, viz.: Botany or Phytology, Zoology and Anthroposophy,—the latter being the science of the human physiological constitution. The radical distinction between animals and man pertains chiefly to the immaterial nature—the latter possessing rational and moral capacities, and also an order of physical nature not possessed by animals; yet a real distinction obtains physiologically, and indeed a vastly greater difference than between any of the different orders of animals. This distinction is stated in the classification. Physiology, which pertains to man's physical nature, is the subscience of Biology, termed Anthroposophy, while comparative physiology, and morphology, belong respectively to Zoology and Phytolcgy—the former relating to beings having sentient but irrational life, and the latter to insentient or unconscious life.

If this method of division, in which Biology and Anthropology share in the inclusion of a special subject appears to be anomalous, it is legitimate; for while both include those sciences which are grouped as belonging to physiological nature, Anthropolcgy includes also the higher order of psychical nature, in essential connection with our mental, rational and moral rature,—entities and attributes of an imperishable subsistence, but whose functions and development for temporal existence depend upon the physiological connection. Biology is the general science of organic being having *Life;* Botany is the special science of organic being having *vegetal life;* Zoology is the special science of organic being having *sentient* life; Anthroposophy is the special science of organic being having *rational* life—the latter term having been chosen to express the distinction maintained above. If it is held by any readers of this paper that animals possess a psychical nature, as well as man, be it so. At least a nervo-ethereal nature may be predicated of beings having sensation and the power of voluntary motion; and such a substratum or basis of the physical as well as the sentient nature of animals, as corresponds with man's psychical nature, may exist, perhaps must. If so, it is reasonable to presume it must be of an order as much lower than man's psychical nature, as the mental or sentient constitution of animals is lower than man's. But if such psychical nature does exist, the fact can be known only by rational induction, for the beast has no capacity for language to verify the assumption.

INCOMPLETE, SUBORDINATE AND CONDITIONING SCIENCES.

Few of the physical sciences, especially, can be completly developed by themselves. Physics, Mechanics and Chemics are more or less mutually related, either as conditioned or conditioning. Astronomy has necessarily required for observation of its facts some of the principles and laws of physical optics, while scientific art has been called to construct appropriate instruments for observation, as the telescope and spectroscope. And the laws of planetary and stellar motion must necessarily be known before the science of astronomy can be fully acquired. But classification cannot await the discovery of all the facts of science, but must proceed with the materials at hand, when radical distinctions have been determined.

Geogony treats of general phenomena, the unformed, but forming and mingling elements, and conditions of meteorology by furnishing the materials involved in the latter science, in its special sphere.

Meteorology cannot be completed as a science by the study of the atmosphere alone, but in connection with the facts which reveal themselves by the action of atmospheric electricity. Thermotics, the science of heat, is but partially developed by the study of the ethereal radiations giving the physical phenomena of heat, but finds its completion in the experiments and application of mechanics, of hydrology and pneumatics.

Paleontology, being allied with mineralogy in respect to the general process of stratification, by furnishing materials which enter into it, properly belongs where it is assigned; yet these materials, constituted in part of fossils, cannot be completed without employing the facts which are brought forward in vital organisms. Hence paleontology is given as a conditioning science, contributing to botany and zoology, inasmuch as the ancient organisms, while many of them contain extinct types, are made a study in connection with living organisms;

and thus the apparent anomaly of the same branch of science being grouped both with physics and biology, is explained by the fact that paleontology, in its mere physical relations, deals with substances irrespective of relations to organisms, while fossilogy belongs to both. So, as already noticed, anthroposophy belongs both to biology and anthropology.

Light and sound are grouped together because produced by vibratory motion, yet not affiliated, because the media of vibration differ, the former being ether and the latter air. The analogy between light and sound is illustrated by firing a cannon at a distance from the observer; first the flash of light is seen at the moment of the explosion of the powder, transmitted at the rate of about 184,000 miles per second, the sound being heard some moments after the flash is seen, transmitted at the rate of about 1100 feet per second. Neither the luminous body nor the sonorous body throws off any *substance*, but only gives an impulse in wave-form causing vibrations of different kinds of substance,—ethereal vibrations exciting the optic nerve causing the sensation of seeing, and aerial vibrations exciting the auditory nerves causing the sensation of hearing. But while acoustics (or photology) is grouped with physical optics, in respect to the cause of their production, both musical sounds and colors are grouped as belonging to esthetics high in the series of science. In these respects both phonology and photology are subordinate sciences.

Actinism, produced by vibration of ether, like light, but exceeding in rate those which produce the highest color, *i. e.*, exceeding 800 billions of miles per second, is affiliated with electricity, light and heat, and bears relations to two diverse and widely separated sciences—photography and phytology. Its action is both chemical and vital, operating on the sensitive silver in photography (which more properly may be termed actinography), and also constitutes the vital agency necessary to excite germination in plants. This latter result has been attributed to the violet ray revealed by the spectrum, but this may be owing to the fact that the higher, inconceivably rapid vibrations of ether producing the actinic rays are not appreciated, and the effects in germination have been associated with the highest rays of light brought within the scope of vision. Actinism is hence grouped generally with sound, and specially with heat, light and electricity, but is subordinate to botany. There are reasons for the theory that electricity is concerned in normal vital action—not only vegetal, but animal.

Nature has anticipated both the mechanic and the fine arts. Far down in the depths of mineralogy are found gems of rarest beauty—the esthetics of Architecture. Up in the field of meteorology the clouds are tinted by the sunbeams with a perfection of beauty surpassing the possibilities of the esthetic art of Painting. "The music of the spheres" have for centuries enchanted the votaries of astronomical science, and still challenges the admiration of all observers contemplating the perfection of that grand choral movement which excels the harmony of a Handel or Beethoven—anticipating the rhythm both of Poetry and Music. Mineralogy, meteorology and astronomy belong to physical science, but they have furnished elements of the esthetic forms which reason appropriates in the sphere and achievements of the Fine Arts.

THE ROTATORY POWER OF COMMERCIAL GLUCOSE.*

A METHOD OF DETERMINING THE PERCENTAGE OF REDUCING MATTER BY THE POLARISCOPE.

By H. W. WILEY, Lafayette, Ind.

In the "trade" the name "grape sugar" is applied only to the solid product obtained from starch.

The name "glucose" is given to the thick syrup obtained from the starch, and which is used in immense quantities in this country for table use and other purposes.

Before being sent into the market it is usually mixed with a little cane sugar syrup to give it color rather than flavor, since the glucose itself is quite or nearly colorless. My polariscope is the *holb-schotten* variety, and is used with the sodium monochromatic light. The sugar scale is graduated to give 100 divisions, with a tube 200 m.m. long filled with sugar solution of 26.048 grammes in 100 c.c.

The angular rotation produced is 34°.7, which shows a specific rotatory power of 66°.6 for pure cane sugar.

In all my examinations I took 10 grammes of glucose in 100 c.c., and used tubes of observation 200 m.m. in length.

The average specific gravity of the various glucoses I examined was 1.412, and the number may be taken as a standard.

In order to conform to the followfng formulæ the specific gravity should not vary greatly from this number.

I have found from a large number of observations that the average reading on the sugar scale for 10 grammes of glucose in 100 c.c. is about 50 divisions. When the reading approached 53 divisions I found that the glucose contained nearly 53 per cent. of reducing matter, as determined by Fehling's solution. When the reading fell below 53 the percentage of reducing matter was above 53 and *vice versa*. I therefore made a large number of observations to determine, if possible, any relation between the polariscopic reading and the percentage of reducing matter.

I found as a result that the difference between the polariscopic reading and 53 multiplied by 1.25 gave a product which, added to or subtracted from 53, would give the percentage of reducing matter required. When we consider the difficulty of hitting the exact point in using the copper solution, the differences exhibited in the following table will not seem so important. See following page.

From a study of the following table we may write the following formulæ:

Let g = percentage of reducing substance, and a = reading of polariscope.

We may have three cases:

1st. $a = 53$.
2d. $a > 53$.
3d. $a < 53$.

For case 1st, $g = 53$ per cent.
Case 2d, $g = 53 - (a - 53)\ 1.25$ per cent.
Case 3d, $g = 53 + (53 - a)\ 1.25$ per cent.

ILLUSTRATIONS.

No. 14, following table.

$a = 40$.
$g = 53 + (53 - 40)\ 1.25 = 69.25$ per cent.

No. 16, following table.

$a = 63.80$.
$g = 53 - (63.80 - 53)\ 1.25 = 39.50$ per cent.

In seven of the seventeen cases given the percentage of reducing matter calculated from the polariscope exceeds that given by the copper solution and by a mean amount of .539 per cent. In ten of them it falls short, and by an average of .938.

In many examinations made subsequent to the above the mean deviation has been even less.

Hence I can say that the method indicated will give results which in the mean differ by less than the half of one per cent. from the reduction tests. I regard my calculations from the polariscope equally as reliable as those made with the copper solution.

* Read before the A. A. A. S., Boston, 1880.

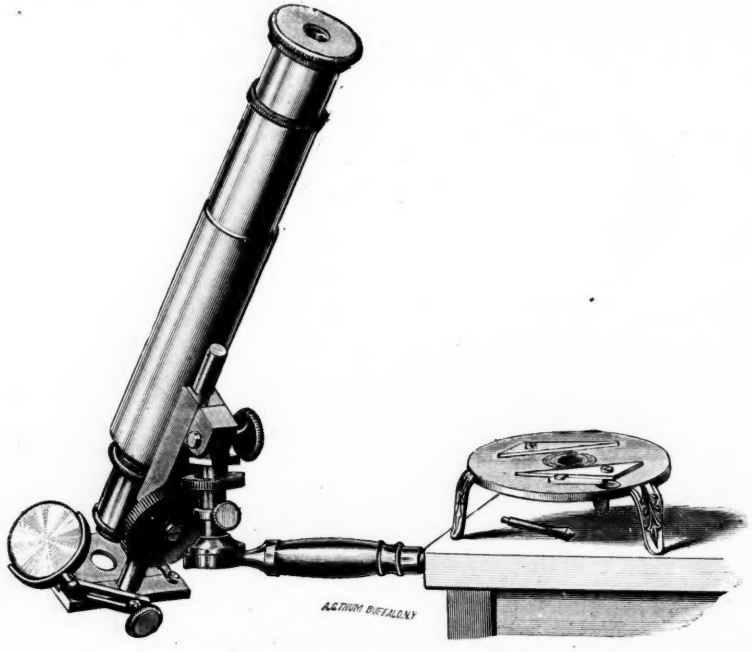
TABLE.

No.	Reading of Poloriscope.	Percentage of Reducing Matter by Copper Solution.	Percentage of Reducing Matter by Polariscope.	+ Differences.	−Differences.
1	52.65	53.20	53.44	.23	....
2	46.07	61.73	61.66	....	.07
3	52.65	52.36	53.43	....	1.07
4	43.05	62.50	64.90	2.40	....
5	48.04	59.35	58.75	....	.60
6	47.70	61.40	59.63	....	1.77
7	49.80	58.80	57.00	....	1.80
8	48.45	58.55	58.56	.01	....
9	50.26	55.60	56.45	.85	....
10	51.50	53.50	54.88	1.30	....
11	50.57	56.49	56.04	....	.45
12	51.74	56.18	54.58	....	1.60
13	40.83	69.93	68.21	....	1.72
14	40.00	69.30	69.25	....	.05
15	50.53	56.34	56.09	....	.27
16	63.80	39.22	39.50	.28	....
17	51.73	54.05	54.37	.32	....

NEW PORTABLE MICROSCOPE.

We present with this number two illustrations showing a new form of portable microscope stand, designed by Mr. E. H. Griffith, and called by him the "*Griffith Club Microscope*," the chief merit of which appears to be its portability, and adaptability to certain positions, which are impossible with the ordinary instruments.

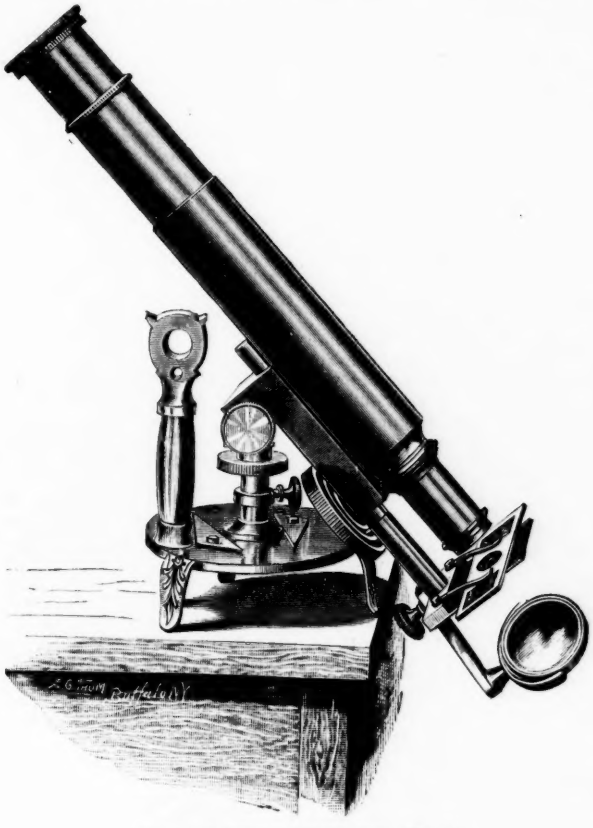
To those familiar with the use of the microscope an examination of the illustrations will suffice to arrive at a clear understanding of what Mr. Griffith has produced. It will be seen that much originality has been displayed, and that novelty of construction is a leading feature. The greatest innovation is the use of an ordinary self-centering turn-table for mounting, as a stand for the instrument; if, however, the turn-table is required for use, the microscope can be closed and used as a stand for the turn-table. The fine adjustment is also an original device of Mr. Griffith, and will be noticed as a large milled-edged screw in the cut. On the inner surface of this cir-



GRIFFITH'S PORTABLE MICROSCOPE. (Fig. 1.)

cular plate is a spiral groove into which works a pin controlling the stage. Mr. Griffith states that with this appliance, a very perfect focal adjustment can be obtained.

Illustration No. 1 shows the instrument attached to a table by a screw support, the mirror placed in position above the stage. As an adjunct to a dissecting table the Griffith microscope, thus used, would be found most useful, occupying no surface space. In excursions it could by the same means be attached to the side of a tree or to a fence. No arrangements have been as yet completed for the manufacture of this instrument, but it is believed they will shortly be made by a firm who will undertake to produce them at a reasonable cost, as Mr. Griffith has aimed to construct a serviceable portable instrument at a moderate price.



GRIFFITH'S PORTABLE MICROSCOPE. (Fig. 2.)

ON CHICKEN CHOLERA: STUDY OF THE CONDITIONS OF NON-RECIDIVATION AND OF SOME OTHER CHARACTERISTICS OF THIS DISEASE.*

BY M. L. PASTEUR.

I.

In the communication which I had the honor of presenting to the Academy in the month of February last, I announced, among other results, that chicken cholera originates in a microscopical parasite; that there is an attenuated virus of this disease, and that one or more inoculations of this attenuated virus may preserve chickens from death when inoculated with the virus of maximum virulence. On account of the striking similarity that these two forms of virus present with the effects of variola and vaccine in man, it becomes interesting to ascertain not only if the immunity from the more aggravated form of virus is absolute, for the regions of the body which have undergone the preventative inoculation, but also if this immunity exists in the system, no matter what portion of the animal may have been inoculated, and what may have been the manner of introducing the virus.†

To explain with brevity the results which I have to communicate, I may be allowed to use the word *vaccinate*, to express the act of inoculating a chicken with the attenuated virus. This being admitted, I may state, as the result of many experiments, that the effects of vaccination are very variable. Some chickens are little affected by the most virulent virus after one inoculation of the attenuated virus; others require two such inoculations, and even three. In every case, the preventive inoculation does some good, be-

* Translated from the *Comptes Rendus de l'Academie de Sciences*, of April 26th, 1880, page 952, by P. Casamajor. The translation of the first paper of this series appeared in the *Chemical News*, vol. xli., page 4 (July 2nd, 1880).

† From all I have seen and read of vaccine in man, and from my experiments on chicken cholera, I infer that *vaccine* rarely acts as a complete preventative. There are cases cited of vaccinated persons who have had the variola, and there are even cases of persons who have had it, afterwards, as much as three times.

cause it acts in a certain measure. Vaccination, then, may be of several degrees; but we may always succeed in completely vaccinating a chicken, which means that we can bring it to such a condition that it becomes incapable of being affected by the most virulent virus.

To make this matter clear, I will now give the results of experiments:—I take eighty new chickens (I call *new* those which never suffered before with chicken cholera). Twenty of these I inoculate with the most virulent virus, and they all die. Of the sixty that remain, I take another lot of twenty, and I inoculate them with that quantity of the most attenuated virus which the point of the needle will take up*—and not one dies. Are they then vaccinated for the aggravated form of virus? Some are and some are not, for if I afterwards inoculate these twenty chickens with the most virulent virus, six or eight of them will not die, although they may be ill, while in the first case every inoculated chicken died. I take again from the remaining chickens another lot of twenty, and these are vaccinated with the attenuated virus exactly as the preceding lot, and, a week afterwards, they are again vaccinated in the same manner. Are they now safe from the virulent virus? We now inoculate these twenty chickens with this virulent virus, and, instead of there being six or eight which do not die, there are twelve or fifteen. Finally, I take the twenty remaining chickens, and vaccinate them successively three or four times. If now I come to inoculate them with the most virulent virus, not one will die. In this case, chickens are brought to the condition of animals which are incapable of suffering from chicken cholera.

As to the cause of non-recidivation, I find it impossible to resist the idea that the microscopic germ, which causes the disease, finds in the body of the animal conditions suitable to its development, and that to satisfy the necessities of its life, the germ alters certain substances, or destroys them, which comes to the same thing, whether it assimilates them, or whether it consumes them with oxygen borrowed from the blood.

When complete immunity has been reached, the most virulent germ may be inoculated into any of the muscles without producing any effect. This means that the cultivation of the germ has become impossible in these muscles. They no longer contain food for the germ.

It is impossible to convey the impression that one receives from observing such phenomena. Here are twenty chickens which never had this disease. I inoculate them in their pectoral muscles or, still better, in the muscle of the thigh, so as to observe with greater ease the effect of the innoculation. The next day all the chickens are lying down; they are very lame and seem overcome by sleep. The inoculated muscle becomes of enormous size, and is profusely filled with the parasites. From time to time, a chicken dies, and, at the end of forty-eight hours they are all dead. We may take also twenty chickens, previously vaccinated several times, and inoculate them at the same time as the others, with the same virus, in equal quantities. The next day and the next, they are all alive and in good health; they eat and cackle as usual; the cocks crow; the inoculated muscles present nothing abnormal. There is not even a sign to show where the skin was punctured. This healthy condition remains permanent.

We may now inquire whether the impossibility of cultivating the parasite is not limited to the muscles which have been inoculated. This may be answered by introducing the deadly virus in the blood vessels and in the digestive organs. I have taken ten chickens, never before inoculated, and ten others inoculated several times with the mild virus. I have then injected the worst form of virus in the jugular vein of all these chickens. The first ten have died rapidly; many of them within twenty-four hours. The ten vaccinated chickens, on the contrary, have only been slightly ill from the incision of the skin and of the jugular vein, and were soon in good health. This shows that the blood of these ten chickens was itself *vaccinated*, which means that previous cultivation had deprived it of the materials fit for further developments of the germ.

As to the introduction of the parasite in the digestive organs, I have imitated the epidemics which depopulate poultry yards, by introducing the parasite in the food of the chickens. On the 11th of March I brought together twelve chickens, bought at the market that very morning, and twelve others, previously vaccinated several times. Every day I gave to these twenty-four chickens a meal of the diseased muscles of chickens, who had died from chicken cholera. Through the combs of the twelve chickens which had not been vaccinated I passed a platinum wire, so as to distinguish them from the other twelve. On the next day the unvaccinated chickens began to sicken and die. On the 26th of march the experiment terminated. Seven of the chickens that had not been vaccinated have died, and a *post mortem* examination reveals the fact that the disease was introduced in the system, either through the first portion of the alimentary canal, or, more frequently, through the bowels, which were highly inflamed, and sometimes ulcerated, in a manner which recalls the lesions of typhoid fever.* The five other unvaccinated chickens are more or less ill, one seriously so. As to the twelve vaccinated chickens, not one has died, and to-day † they are all alive, and in good health. We may now sum up the results as follows:

It is the life of a parasite, in the interior of the body, which causes the disease known as chicken cholera and which causes death by this disease. When the cultivation of this parasite cannot take place in the body of a chicken, the disease does not show itself. The chicken is then in the constitutional condition of animals which chicken cholera cannot attack. Animals in this condition may be said to be born vaccinnated for this disease, because the fœtal evolution has not placed in their bodies the proper food of the parasite, or because substances, which could serve as such food, have disappeared while they were yet young. We must not wonder that there are constitutions more or less apt to receive inoculations of certain kinds of virus, for, as was announced in my first note, the broth of beer-yeast is entirely incapable of supporting the life of the parasite of chicken cholera, while it is well adapted to the cultivation of a multitude of microscopical germs, notably of the bacteridia of carbuncular disease.

The explanation to which we are led by the facts already mentioned, of the different degrees of constitutional resistance of some animals, as well as of the immunity which chickens acquire by preventive inoculations, must seem a natural one, if we take into consideration that every cultivation modifies the medium in which it takes place. In the case of ordinary plants, the soil is modified, in the case of parasites, the animals and plants on which they live are also modified. The same thing happens with the liquids in which they live, in the case of ferments and other microscopical germs. The modifications which take place have this character in common, that new cultivations of the same species in these media soon became difficult or impossible. If chicken-broth is used for cultivating the germ of *chicken cholera*, and if, after three or four days, the liquid is filtered, to separate all the germs, and furthermore, if after this fresh quantities of the germs are placed in the filtered liquid, it will

* There are degrees of attenuation as well as of virulence. I will give explanations in a future communication.

* The blood is full of parasites, and the interior organs are frequently covered with pus and false membranes, particularly next to the intestinal pockets, through which the germ seems to have penetrated.

† April 26th.

be found incapable of producing the feeblest development. Perfectly limpid at first, the liquid remains indefinitely limpid.

We are led to believe that the cultivation of the attenuated virus in a chicken places its body in the same state as that of the liquid which can no longer sustain the life of the germ of disease. We may extend the comparison still further, for, if we filter the broth on the second day of the cultivation, instead of on the fourth, the filtered liquid will still permit the cultivation of the germ, but less readily than at first. This may enable us to understand that the cultivation of the attenuated germ in the body of a chicken may not have removed all the food for the germ. The remainder may allow a fresh cultivation of a feebler kind. This is the same as a first *vaccination*. Subsequent inoculations will remove progressively all the materials for the cultivation of the parasite. Through the action of the circulation, a time will come when any new cultivation on the animal will remain unproductive. Then the disease cannot recidivate, and the subject becomes perfectly vaccinated.

It may seem astonishing that the first cultivation could have stopped before all the food of the germ has been destroyed; but we must not forget that the germ is aerobian,† and that, in the body of an animal, it does not find the same conditions as in an artificial medium of cultivation, in which there are no obstacles to its propagation. In the body, on the contrary, it finds opposition from the cells of the organs, which are also aerobian, and are continually absorbing oxygen.

We might also account for the fact of non-recidivation by admitting that the life of the germ, instead of destroying certain substances in the body of an animal, on the contrary, adds other substances which act as an obstacle to its further development. The history of the life of these inferior beings, of all beings in fact, authorizes this supposition. The excretions due to vital functions often prevent vital functions of the same nature. In some fermentations, antiseptic products are formed while fermentation is going on, and even by the action of ferments, and these products put an end to further action, even if there are still substances left capable of undergoing fermentation. In the cultivation of our germ, there might, in the same way, be substances formed whose presence might explain non-recidivation and vaccination.

Our artificial cultivation of the parasite will enable us to examine this hypothesis. If we prepare an artificial cultivation of the germ of chicken cholera, we may evaporate the liquid *in vacuo* while cold, then bring it back to its original volume by the addition of chicken broth. If the extract contains a poison which destroys the germ, and if the presence of this poison is the cause of its non-development, the cultivation of the germ cannot take place in this liquid. On the contrary, the development does take place without difficulty. We cannot then believe that, during the life of the parasite, there are substances produced which prevent its further development. This is a corroboration of the opinion which we have expressed on the cause of non-recidivation in certain virulent diseases.

DENSITY OF LIQUID OXYGEN.—J. Offret has revised Pictet's calculation of the density of liquified oxygen and considers the method inadmissable. His own calculation gives 0.840.

EXPLOSIVE ANTIMONY.—A solution of crystalline antimony chloride and hydrochloric acid at 1.12 sp. gr. was prepared so as to stand at 38° B. On electrolysis with the Lechlanché element there was obtained in twenty to twenty-four hours a most explosive deposit.—E. MASCARENAS Y HERNANDEZ.

† Pasteur divides germs and other microscopic organisms into *aerobians* (requiring air to live) and *anaerobiæ* (which do not require air).—*Translator.*

ASTRONOMY.

THE Roman Academy of Sciences has awarded half of the King Hubert Prize to Dr. Wilhelm Temple, Director of the Acetri Observatory at Florence, for his observations on Nebulæ.

THE second Part of Vol. II. of papers relating to the Transit of Venus has recently been published by the Paris Academy of Sciences. It contains, among other things, the last of the Memoirs relating to the expedition to the island of St. Paul, the Meteorology by Dr. Rochefort, and the Geological Researches made at Aden, Reunion, St. Paul, Amsterdam and Seychelles, by M. Vélain. The first Part of Vol. III., which is to contain a report of the work done at Campbell Island, is in preparation.

THE "Reports of the Total Solar Eclipses of July 29, 1878, and January 11. 1880," forming Appendix III. to the "Washington Observations for 1876," has just been distributed from the Naval Observatory.

OWING to an error in the telegraphic dispatch, the discoverer of Comet *f*, 1880, was called *Pennule*. It should have been *Dr. C. F. Pechüle*, of Copenhagen. The comet seems to have two tails, one pointed towards the sun, and the other pointed about N. 15° *f*.

ASTRONOMICAL MEMORANDA: — (Approximately computed for Washington, D. C., Monday, February 7, 1881.)

Sidereal time of Mean Noon, $21^h\ 11^m\ 49^s$.
Equation of time, $14^m\ 25^s$.
Mean noon *preceding* apparent noon.

The *Moon* crosses the meridian at about 8.30 P. M. Full moon occurs on the 13th, and the last quarter on the 21st of the month:—New moon on the 29th.

Mercury is still evening star, following the sun by nearly an hour. He reaches his closest position to the sun on the 21st, and "greatest elongation" on the 22nd.

Venus is still the most conspicuous object in the evening sky. She increases her apparent distance from the sun until Feb. $20^d\ 7^h$, when she reaches "greatest elongation" East, an angular distance of 46° 34'.

Mars crosses the meridian at about 10 o'clock in the morning. He is nearly 23° south of the equator.

Jupiter and Saturn form with Venus an unusually good opportunity for the amateur astronomer to make use of his telescope in the early part of the evening. Jupiter and Venus will be in conjunction on the 21st.

Uranus is on the meridian about two hours after mid-night, and *Neptune* about half-past five in the afternoon. Uranus is in conjunction with the moon on Feb. 15th.

The *Comptes Rendus* for Jan. 3, 1881, contains a paper by M. Rouget upon a method for use at sea, and for travelers, explorers and others, for determining latitude and sidereal time, dispensing with the measurement of angles.

Two stars are observed having at a given moment, the same altitude: such observations are combined in pairs, and by merely noting the time which has elapsed between the two observations, a simple interpolation in tables prepared for the purpose will give the sidereal time and the latitude of the place of observation. Formulæ are given for the case mentioned above, and also for deducing the latitude and sidereal time from stars having the same azimuths, or azimuths differing by 180°. A succeeding paper by the same author extends the formulæ to the determination of longitudes, by employing observations of the moon.

W. C. W.

ON THE FIRST COMET OF 1861 AND THE METEORS OF APRIL 20.

By Professor Daniel Kirkwood.

M. Arago was the first to call attention to the frequent appearance of shooting stars in unusual numbers about the 20th of April, and to suggest the theory[1] that they are derived from a ring which intersects the earth's orbit. We are indebted, however, to the late Edward C. Herrick, of New Haven, for the collection of the principal facts by which the suggestion of Arago was fully sustained.

I.

THE GREAT METEORIC SHOWER OF APRIL 20, 1803.

More than thirty-six years after the event the old newspaper accounts of this wonderful display were sought out by Mr. Herrick and rescued from oblivion.[2] The following description of the phenomena as seen at Richmond, Va., is taken from the Virginia *Gazette*, of April 23, 1803.

"*Shooting Stars.*—This electrical phenomenon was observed on Wednesday morning last, at Richmond and its vicinity, in a manner that alarmed many, and astonished every person that beheld it. From one until three in the morning, those starry meteors seemed to fall from every point in the heavens, in such numbers as to resemble a shower of sky rockets. The inhabitants happened at the same hour to be called from their houses by the fire-bell, which was rung on account of a fire that broke out in one of the rooms of the Armory, but which was speedily extinguished. Every one, therefore, had an opportunity of witnessing a scene of nature, which never before was displayed in this part of the globe, and which probably will never appear again. Several of these shooting meteors were accompanied with a train of fire, that illuminated the sky for a considerable distance. One, in particular, appeared to fall from the zenith, of the apparent size of a ball of eighteen inches diameter, that lighted for several seconds the whole hemisphere. During the continuance of this remarkable phenomenon, a hissing noise in the air was plainly heard, and several reports, resembling the discharge of a pistol. Had not the city bell been ringing, these reports would probably have seemed louder. The sky was remarkably clear and serene, and the visible fixed stars numerous the whole night. We are anxious to know at what distance from Richmond this phenomenon has extended. It is hoped that persons who have remarked it in other places will not neglect to inform the public of the particulars; as such information may add in a great degree to the knowledge of meteorology.

Since writing the above, we have been informed that several of the largest of these shooting meteors were observed to descend almost to the ground before they exploded. Indeed, many of those which we saw, appeared to approach within a few yards of the house tops, and then suddenly to vanish. Some persons, we are told, were so alarmed that they imagined the fire in the Armory was occasioned by one of these meteors, and in place of repairing to extinguish the earthly flames, they busied themselves in contriving to protect the roofs of their houses from the fire of heaven."

The display was also witnessed at Raleigh, N. C.; Wilmington, Del.; Schoharie County, N. Y.; Portsmouth, N. H.; and at several points in Massachusetts. The descriptions of the shower as seen at these respective localities declare that, "the heavens seemed to be all on fire from the abundance of lucid meteors;" that they were "too numerous to be counted;" and that "part of the time the light was so great that a pin might be picked up on the ground." The shower, in short, would seem to have been one of the most extensive and brilliant on record, and hence to have been derived from a meteoric cluster of extraordinary density.

According to the catalogues of Biot and Quetelet[3] a great meteoric shower was seen in China on the 16th of March, B. C. 687. This date corresponds with the 20th of April in the nineteenth century. The display was therefore a shower of Lyraids. The interval between this extraordinary apparition and that of 1803 was 2490 years which may be regarded as a multiple of the true period.

The year 558 of our era,[4] midway between those brilliant displays, was the date of another great meteoric shower. The month and day are not given, but we may assume with reasonable probability that it was the great April display. Mr. Herrick found several other showers derived from the same stream. They seem, however, to have been of inferior brilliancy. They will be considered hereafter.

II.

THE FIRST COMET OF 1861.

The first comet of 1861 was discovered by Mr. Thatcher on the 4th of April. It was visible to the naked eye, and had a tail three degrees long. Its elements, calculated by Dr. Oppolzer, of Vienna, are as follows:

ELEMENTS OF THE FIRST COMET OF 1861.

Perihelion Passage	1861, June 3.
Longitude of Perihelion	243° 22'.
Longitude of Ascending Node	29° 55'.
Inclination	79° 45'.
Eccentricity	0.98345.
Semi-axis Major	55.67
Period	415.4 years.
Perihelion Distance	0.9207.
Aphelion Distance	110.425.
Motion	Direct.

Professor George Forbes has shown[5] that the comets of 1444, 1032 and 616 were former apparitions of this comet; the mean of the three periods being 415 years. The dates of ancient perihelion passages would therefore have been about A. D. 201, B. C. 214, and B. C. 629. In 1867, soon after the discovery, by Schiaparelli and others, of the connection between the comets of 1862 and 1866 with the August and November meteors, the probability of a similar relation between the first comet of 1861 and the meteors of April 20th was pointed out by Drs. Weiss and Galle.[6] The orbit of the comet nearly intersects that of the earth in longitude 210°, the point passed by the earth at the epoch of the April meteoric shower. An approximate equality of the periods of the comet and the meteoric stream was thus rendered highly probable.

The facts here collated constitute several very striking coincidences.

1. Dr. Oppolzer's period of the comet, derived solely from observations, is 415 years.

2. The mean period from 616 to 1861 was 415 years.

3. The interval between the great meteoric showers of B. C. 687 and A. D. 1803 is equal to 6 periods of 415 years.

4. The shower of A. D. 558 was midway between B. C. 687 and A. D. 1803.

5. The comet and the meteoric swarm seem to have equal periods.

It is by no means surprising that all returns of the meteoric group have not been recorded. The observations were restricted to the eastern continent; or, as

[1] In 1836.

[2] See Herrick's article in the Am. Journ. of Sci. for July, 1839, p. 358.

[3] Quetelet's Physique du Globe, p. 290.

[4] Quetelet's Catalogue.

[5] In a paper read before the Royal Society of Edinburgh, Feb. 16, 1880.

[6] Astr. Nach., Nos. 1632, 1635, and 1710.

Herrick has remarked, "some of them have doubtless been concealed by clouds, and others witnessed only by barbarians."

But between the great display of B. C. 687 and A. D. 1803, Professor Newton gives the following list of showers at or near the epoch of April 20,[7] viz.: B. C, 15, A. D, 582, 1093, 1094,[8] 1095, 1096, 1122 and 1123. The appearance of 582 ought probably to be rejected. It was two days from the epoch, and the record as quoted by Quetelet may have no reference to shooting stars.[9] The three remaining returns, B. C. 15, A, D. 1093-1096, and 1122-3, indicate a period of about 27 years. Now it is obvious that, at every close approach of meteors to the earth, many must be thrown into new orbits, all of which will pass through the point at which the perturbation occurred. It seems probable, therefore, that at some remote epoch a considerable cluster of this meteoric stream was thrown by perturbation into a new orbit corresponding to a period of 27 years. The change may have been produced by the earth during the passage of the meteoric swarm.

The facts which we have considered apparently indicate that the first comet of 1861, and the April meteors, formed a system in space before entering the solar domain; the latter moving in advance of the former at a distance comparable to the diameter of Neptune's orbit. By planetary perturbation the orbits were transformed into ellipses. If, as supposed by Professor Forbes, the disturbing body was an ultra-Neptunian planet in the vicinity of the present aphelion of the comet's orbit, said planet would probably describe less than 20° of its circuit during the interval between the nearest approach of the two bodies. But in aphelion the comet 1861 I, is too remote from the plane of the ecliptic to be sensibly disturbed by a planet moving in that plane. It seems more probable that the comet, as well as the meteoric group, owes the transformation of its orbit to one of the known major planets. Its radius vector when at its ascending node is about 10. In other words, its orbit approaches very near that of Saturn in longitude 30°. Now, it is remarkable that the interval between the perihelion passages of the meteors and the comet is almost exactly equal to two periods of Saturn. The meteors and Saturn were in the same longitude and in close proximity about B. C. 683, and the comet approached very near the planet at the same point about B. C. 625. The orbits may have been transformed into ellipses by Saturn's influence at these respective epochs. It may be worthy of remark that 11 times the period of the comet are equal to 155 times that of Saturn.

CHEMICAL NOTES.

On Ballo's Supposed Adipic Acid Obtained from Camphor.—On oxidation with chromic acid camphor does not yield adipic acid, but the same oxidation-products as with nitric acid. Chromic acid, however, converts the camphoric acid first formed completely into members poorer in carbon.—J. Kachler.

On the Remarkable Reducing Properties of Potassium Ferrous Oxalate, and on some of the Reactions thus Produced.—Ferrous oxalate is very permanent on exposure to the air, both in a wet and a dry state, and possesses very feeble reducing properties. The solution of ferrous oxalate in potassium oxalate, as well as the solid double salt, takes up oxygen greedily, and passes into potassium ferric oxalate. Its affinity for oxygen is equal to that of an alkaline ferrous hydrate, or of ammoniacal cuprous chloride, or of pyrogallic acid in an alkaline solution. The double oxalate exerts its reducing powers, not merely in alkaline, but in neutral, and even acid solutions. The solution quickly reduces platinum chloride and silver nitrate to metal. Silver chloride, bromide, and iodide are reduced completely, but more slowly. Copper acetate is reduced very slowly to cuprous oxide, and even to metal With the aid of heat mercuric chloride is reduced to metal. Recently precipitated Prussian blue is reduced to white ferro-cyanide of potassium. Indigo blue is reduced to white indigo, and solutions of sulphindigotic acid are rapidly decolorised.—J. M. Eder.

On the Acids $C_8H_{14}O_4$ Formed from Butyric Acid. Besides a volatile oily acid, probably identical with isocrotonic acid, there are formed by the reaction of suberic and bromobutyric acid, two acids agreeing in composition with suberic acid, but distinctly different from each other, and from the two isomeric acids produced by a corresponding reaction with brom-isobutyric acid. There exist, therefore, five isomeric suberic acids.—Carl Hell and O. Mulhauser.

A New Synthesis of Phosphenyl Sulpho-Chloride.—Twenty parts phosphenyl-chloride are placed in a small flask with a reflux condenser, and five parts sulphur-chloride are slowly added by means of a dropping-funnel. After the reaction is over, the flask is set in a freezing mixture of Glauber's salt and hydrochloric acid. Pale yellow crystals of phosphenyl-tetra-chloride are formed, from which the liquid is separated by decantation, then shaken with water, dried and rectified. The yield is almost quantitative.—H. Koehler.

More Particular Observations on the Action of Potassium Carbonate upon Isobutyl-aldehyde.—F. Urech places about 3 grms. pure isobutyl-aldehyde in a narrow test tube graduated in half millimetres. With a lens it is possible to read accurately quarter millimetres. After 3 decigrms. of finely-powdered recently-ignited potassium carbonate have been added, the tube is closed, set in a horizontal position, and the level is read off every five minutes for forty-eight hours. The liquid will be found to have sunk from 21.50 to 14.50 degrees.

At a meeting of the Société Industrielle of Mulhouse, it was stated that tin sulphocyanide, formed by the double decomposition of calcium sulphocyanide and tin oxalate, is found very useful in calico printing.

For printing cotton with the azo-colors, Dr. Allrich proposes to dissolve 100 grms. of the color in five times its weight of water; then to make up a solution of sodium stannate or aluminate at 15° B., to every litre of which are added 20 grms. alizarin oil. Of this mixture 150 grms. are incorporated with the color, which is then thickened with starch and printed. After printing the pieces are steeped for an hour in lead or barium acetate or barium chloride at 5° to 10° B., and washed in cold water.

CORRESPONDENCE.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. No notice is taken of anonymous communications.*]

To the Editor of "Science:"

In reference to the correction of one of my statements made in your issue of the 29th inst. by Dr. Burt G. Wilder, I would say that I accept the criticism in all its bearings. The view which Dr. Wilder expresses regarding the upper wall of the third ventricle being constituted by the *ependyma* stretched across between the *habenulæ* of the pineal gland, was once entertained by myself (in accordance with the orthodox view of embryologists since the time of Rathke), and was the one which Dr. Wilder may perhaps recollect I expressed to him in conversation last year. I return to that view again. My abandonment of it was due to the confounding of two distinct questions, *i. e.*, the question of the true inner boundary of the floor at the lateral ventricle and the true upper and outer boundary of the third. The view I should have credited to Wilder and Hadlich, is that the *lateral ventricle does not* extend over the thalamus. My misapprehension of Wilder's statement is based on the fact that it rested on a verbal communication. That I mentioned it at all was

[7] Am. Jour. of Science, July, 1863.

[8] "At this period, so many stars fell from heaven that they could not be counted. In France the inhabitants were amazed to see one o thenmsfi great size fall to the earth, and they poured water on the spot, we hish their exceeding astonishment smoke issued from the ground with aoot f-ing noise."—Herrick's Catalogue. This record is of great interest as indr cating the fall of an aerolite during the shower of meteors.

[9] "A Soissons, on voit le ciel en feu. Une pluie de sang tombe sur Paris."

due to my unwillingness to adopt even unpublished views of others without at least giving formal credit. If my good intentions have in this instance had rather the effect of doing an injustice, that was not a matter of intent, but of error, and one I may claim an excuse for under the circumstances above explained.

Dr. Wilder refers to the absence of literary references in my short paper. This is in accordance with the fact that the paper was a provisional communication of results purely my own, and that quotations of the views of others were limited to such relating to collateral details or of works like those of Luys and Meynert, which are so much household words among cerebral anatomists that I thought a mention of their exact titles a useless affectation.

On reviewing the matter, I find that the relations are in every respect as Dr. Wilder gives them, viz.: 1st. That the lateral and third ventricles only communicate through the Foramen of Monro. 2d. That the medial aspect of the Thalamus only is in the third ventricle. 3d. That no part of the Thalamusis in the lateral ventricles. 4th. That the dorsal aspect of the Thalamus is neither in the third nor in the lateral, nor in any other ventricle.

My description of the third ventricle as a T shaped slit, requires this modification, that the vertical branch alone is ventricular, the horizontal being neither a part of the lateral nor of the third ventricle, but a *fissure* extending between the thalamus and the cerebral hemispheres.

While thus embryologically and morphologically the thalamus must be looked on as a distinct cerebral segment, yet in the higher mammalia (as I claimed some years ago) it has become practically a subsidiary ganglionic depot of the cerebral hemispheres, and thus assumes a position not without its analogies to that of the *Corpus striatum;* a view in full accord with that of Meynert.

In conclusion I would offer a formal apology for the erroneous interpretation I made of Dr. Wilder's views, and state that the communication I made was merely provisional, and intended to be followed up by more full essays on the different subjects mentioned therein, in which the necessary literary references will not be wanting.

I also trust that Dr. Wilder will, in his publication, enlighten us on the anterior termination of the "extraventricular" slit which extends over the thalamus and under the Fornix. I am unable to determine this question from my sections, which are chiefly made in the transverse direction, and in which the ependymal roof of the third ventricle was either absent or removed by the knife. This feature was in part responsible for my misapprehension of the shape of the third ventricle. Respectfully,

NEW YORK, February 3d, 1881. E. C. SPITZKA.

RECURRING PERIODS IN THE WEATHER.

To the Editor of "SCIENCE:"

Last year I published in the New York *Tribune* a table for the month of February showing the dates of rain and snow in that month for twenty years. I also pointed out that there seemed to be two well marked storm periods, about the 3rd and 20th of that month, when a storm might be expected. Since then I have made some corrections in the dates as then published and have extended my investigation to all the rest of the months. The result will be found in the table below; the table gives the dates of rain or snow as observed at Newburgh, N. Y. In all cases the blanks indicate that I had no observations for those dates. I would be very much obliged to any of the readers of "SCIENCE" who may have observations for these missing dates if they would publish them in "SCIENCE." For example, did it rain about 3rd of August 1862, May 1877, August 1873, August 1874, August 1876 and 1877, or about September 3, 1869? The missing dates from the 20th I would also be very much pleased to have supplied. An examination of the table will show that there seems to be two well marked storm periods in each month, and that a storm may be expected about the 3rd and 20th of every month. The crucial test for any theory concerning the weather is to see how accurately it predicts for any one place. It will readily be comprehended that the larger the area we predict for, greater is the probability of our predictions coming true, for if it does not storm at one place it may at another. Had I felt justified in using observations made in the vicinity of Newburgh, the table would have agreed much closer with theory, but I have only used the dates on which storms occurred at Newburgh. Besides, when the storm was very light near the 3rd or 20th, I have in some cases omitted it and recorded the date of the next storm. Thus, for example, it snowed at Newburgh December 21, 1880, but it did not last long, and I have recorded the heavier storm of December 25th; and in September, 1864, it rained before the 30th, but as it was very light, I omitted it and recorded the first rain of any amount after the 20th. However, my object will be accomplished if this article should direct the attention of observers to the importance of paying more attention to the recurring periods in the weather, on which Vennor has founded his predictions which have proved so true in many instances.

JAMES H. GARDINER.

NEWBURGH, N. Y.

YEAR.	Jan.	Feb.	March.	April.	May.	June.	July.	August.	Sept.	Oct.	Nov.	Dec.
1860	3 26	3 18	1 20	1 21	3 19	1 20	3 21	4 21	8 21	2 14	6 18	4 20
1861	3 20	3 20	3 19	3 24	1 25	2 19	6 20	8 22	3 18	5 19	2 21	1 23
1862	5 20	3 19	3 20	2 20	2 19	3 19	5 20	.. 22	1 17	4 19	6 19	3 22
1863	2 21	1 20	3 25	4 23	4 17	2 21	2 20	8 22	12 19	3 19	3 19	3 22
1864	1 19	1 24	2 20	2 25	3 21	1 20	2 25	3 21	4 30	2 28	4 21	3 21
1865	4 19	5 26	3 21	6 20	1 18	9 19	1 21	3 21	2 18	4 19	4 21	10 19
1866	12 20	2 19	4 20	7 22	2 20	3 22	4 20	2 21	4 20	14 22	11 22	7 20
1867	1 20	3 20	3 21	5 20	6 19	2 18	4 20	3 20	5 19	5 21	11 20	4 19
1868	1 21	9 19	2 21	2 20	2 21	2 21	3 24	3 20	3 20	1 21	2 18	4 20
1869	4 18	3 18	2 19	1 20	3 19	1 20	3 26	4 21	.. 25	3 28	5 20	5 20
1870	5 17	5 20	4 21	4 21	7 24	7 ..	3 28	4 25	3 17	11 20	3 19	4 21
1871	2 20	8 18	3 21	4 20	3 17	3 20	4 22	5 ..	3 19	2 18	1 22	5 19
1872	3 19	3 25	4 23	1 21	4 19	4 25	4 18	6 21	5 19	3 20	3 20	3 20
1873	2 20	3 21	2 20	3 21	3 21	6 23	1 19	.. ..	.. 19	4 20	7 18	2 18
1874	2 21	3 20	4 22	4 19	3 21	3 20	2 ..	.. ..	.. 19	2 21	9 20	1 20
1875	2 18	3 20	3 20	3 18	2 19	7 18	4 18	3 19	10 19	1 16	2 19	5 21
1876	2 19	3 21	1 20	3 20	4 20	3 20	2 20	.. 17	1 21	5 21	6 20	2 21
1877	2 22	2 16	2 21	2 20	.. 21	5 21	1 17	.. ..	6 28	4 21	2 24	5 21
1878	2 20	1 21	3 18	2 ..	1 20	4 22	4 22	1 20	3 21	6 19	6 20	2 21
1879	2 21	5 20	4 21	3 19	5 19	3 22	4 22	4 19	3 22	9 19	2 19	4 19
1880	4 20	3 21	2 20	3 20	2 22	2 20	3 20	3 21	7 20	4 22	5 20	5 25
1881	4 21											